SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 2472F

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Superseding AMS 2472E

Anodic Treatment of Aluminum Alloys Sulfuric Acid Process, Dyed Coating

RATIONALE

This specification revision was issued as part of the SAE Five Year Review process.

NOTICE

ORDERING INFORMATION: The following information shall be provided to the processor by the purchaser.

1) Purchase order shall specify not less than the following:
   - AMS 2472F
   - Basis metal to be anodized
   - Required color
   - Special features, geometry or processing present on parts that requires special attention by the processor
   - Quantity of pieces to be anodized

2) Parts manufacturing operations such as heat treating, forming, joining and media finishing can affect the condition of the substrate and adversely affect the finished part. The sequencing of these types of operations should be specified by the cognizant engineering organization or purchaser and is not controlled by this specification.

1. SCOPE

1.1 Purpose

This specification establishes the requirements for dyed anodic coatings on aluminum alloys.

1.2 Application

This process has been used typically to increase corrosion resistance and to produce colored surfaces on aluminum alloy parts, but usage is not limited to such applications.

1.2.1 AMS 2470 or AMS 2471 should be specified for coatings to be used as a base for paint or other organic finishes. This process is not suitable for parts which contain joints or recesses in which the anodizing solutions may be retained.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

1.3 Classification

This specification covers two types of coating classified as follows:

Class 1 - Coatings for Identification
Class 2 - Coatings for Decorative Purposes

When no class is specified, Class 1 shall be supplied.

1.4 Safety - Hazardous Materials

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS 2470	Anodic Treatment of Aluminum Alloys, Chromic Acid Process
AMS 2471	Anodic Treatment of Aluminum Alloys, Sulfuric Acid Process, Undyed Coating
AMS 2473	Chemical Film Treatment for Aluminum Alloys, General Purpose Coating
AMS 4037	Aluminum Alloy, Sheet and Plate, 4.4Cu - 1.5Mg - 0.60Mn, (2024; -T3 Flat Sheet, - T351 Plate), Solution Heat Treated

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM B 117	Operating Salt Spray (Fog) Testing Apparatus
ASTM B 137	Measurement of Mass of Coating on Anodically Coated Aluminum

3. TECHNICAL REQUIREMENTS

3.1 Solutions

3.1.1 Electrolyte shall be an aqueous solution of sulfuric acid of suitable concentration (8.2.2) maintained within ± 2 °F (± 1 °C) of the temperature approved in 4.4.3.

3.1.2 Dye shall be as required to produce the specified color.

3.1.3 Sealer shall be an aqueous solution of nickel acetate or cobalt acetate or other solution acceptable to the cognizant engineering organization. See 8.2.3.

3.2 Preparation

3.2.1 Cleaning and Deoxidation

Parts shall have clean surfaces, free from water break, prior to immersion in the anodizing bath.

3.2.2 Masking

Areas where anodizing is prohibited shall be masked.

3.2.3 Tight electrical contact shall be maintained during the anodic treatment to prevent contact arcing (burning) of parts, but small irregularities of coating at points of electrical contact are acceptable. For parts which are to be anodized all over, locations shall be acceptable to the cognizant engineering organization. For parts which are not to be anodized all over, locations shall be in areas on which coating is not required.

3.3 Procedure

3.3.1 Anodizing

The cleaned parts shall be made the anode(s) in the electrolyte contained in a chemical- resistant tank which may also serve as the cathode. The processing shall be adjusted to obtain the required weight and quality of the coatings. The anodizing current shall be maintained within ± 2 amperes per square foot (± 21.5 A/m^2) of the nominal value. Alternatively, the anodizing current shall be ramped up over a five minute, or other preselected period, to the desired final voltage and maintained until the anodic coating reaches the desired thickness. After anodizing, parts shall be rinsed thoroughly in water at ambient temperature.

3.3.2 Dyeing

Prior to sealing, parts shall be dyed to the specified color by immersing in a appropriate dye solution. The temperature of the solution and the time of immersion shall be as necessary to produce the specified color. Parts shall then be rinsed in clean water at ambient temperature.

3.3.3 Sealing

Parts shall be immersed in the sealer solution for a suitable time. See 8.2.11. After sealing, the parts shall be thoroughly rinsed in clean water at ambient temperature, rinsed in clean hot water, and dried.

3.4 Properties

Coated parts shall conform to the following requirements:

3.4.1 Coating Weight

The coating weight (4.3.2.1) shall be determined in accordance with ASTM B 137 and shall comply with Table 1.

TABLE 1 - COATING WEIGHT REQUIREMENTS

Class	Coating Weight, mg/square foot (g/m^2)
1	600 (6.5)
2	2500 (27)
2 (high copper content alloys*)	1400 (15)

*Wrought aluminum alloys of the 2000 series where copper is the major alloying element and aluminum casting alloys with a nominal copper content of 1% or higher.

3.4.1.1 If small parts, such as rivets or machine screws, are anodized in bulk in a container, the specified coating weight shall apply to not less than 75% of the parts treated together, determined by random sampling, but in no case shall any part show uncoated areas.

3.4.2 Corrosion Resistance

Panels (4.3.2.2) shall meet the following requirements, determined after exposure for not less than 336 hours to salt spray corrosion test in accordance with ASTM B 117, except that significant surface shall be inclined 6 degrees from vertical. The five test panels shall show not more than a total of 15 isolated pits none larger than 1/32 inch in diameter, in a total of 150 sq inches (968 cm^2) of test area. Areas within 1/16 inch (1.6 mm) of identification markings or of an edge or at electrode contact marks shall not be included. Individual test specimens shall show no more than five isolated pits none larger than 1/32 inch in a total of 30 sq. inches (194 cm^2). See 8.3.1.

3.5 Touch Up

Parts on which the anodic coating has been scratched or damaged superficially may be coated using AMS 2473 or other method acceptable to the cognizant engineering organization. Touch up, unless otherwise specified, shall not exceed 0.5 inch (13 mm) in its longest dimension, except that scratches that are essentially one dimensional (less than 0.03 inch (0.8 mm) wide) may be reworked. The total reworked area shall not exceed 5% of the total surface area.

3.6 Quality

Anodic coating, as received by purchaser, shall be continuous, smooth, adherent, and uniform in appearance, and shall be free from powdery areas, loose films, discontinuities such as breaks or scratches (except at contact points), or other damage or imperfections detrimental to usage of the coating. Slight variations in color between cast and machined surfaces, between welds and adjacent areas, due to grain size or grain flow variations, or due to variation in alloy composition from lot to lot, are acceptable.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The coating processor shall supply all samples for processor's tests and shall be responsible for the performance of all required tests. Parts, if required for tests, shall be supplied by purchaser. The cognizant engineering organization reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that processing conforms to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Quality (3.6) and color (3.3.2) are acceptance tests and shall be performed on parts, or samples representing parts when permitted, from each lot.

4.2.2 Periodic Tests

Coating weight (3.4.1) and corrosion resistance (3.4.2) are periodic tests and shall be performed at least monthly unless frequency of testing is specified by the cognizant engineering organization. Tests of cleaning and processing solutions are periodic tests and shall be performed at a frequency established by the processor unless frequency of testing is specified by the cognizant engineering organization. See 8.4 and 4.4.3.

4.2.3 Preproduction Tests

All property verification tests (section 3.4) are preproduction tests and shall be performed prior to or on the initial shipment of processed parts to a purchaser and when the cognizant engineering organization requires confirmatory testing.

4.3 Sampling and testing shall be not less than the following: a lot shall be all parts of the same part number, processed in a continuous series of operations (3.3.1 to 3.3.3, inclusive) in not longer than 24 consecutive hours, and presented for processor's inspection at one time.

4.3.1 Acceptance tests

Test samples shall be randomly selected from the lot. The minimum number of samples shall be as shown in Table 2.

TABLE 2 - Sampling for Acceptance Testing

Number of Parts In Lot	Quality and Color
Up to 7	All or 7*
8 to 15	7
16 to 40	10
41 to 110	15
111 to 300	25
301 to 500	35
Over 500	50

* Whichever is less

4.3.2 Periodic Tests

Sample quantity shall be selected at the discretion of the processor, unless otherwise specified.

4.3.2.1 Coating weight shall be determined on representative parts when size and shape permit accurate determination of surface area. If parts are of such size and shape that surface area cannot be determined readily, coating weight determinations shall be made on separate test panels 0.025 to 0.063 inch (0.64 to 1.60 mm) thick and not less than 3 inches (76 mm) square fabricated from 2024 aluminum alloy in accordance with AMS 4037.

4.3.2.1.1 Separate test panels, if used, shall be processed with the work they represent.

4.3.2.2 Corrosion resistance shall be determined on five separate test panels 0.025 to 0.063 inch (0.64 to 1.60 mm) thick and not less than 3 x 10 inches (76 x 254 mm) in width and length fabricated from 2024 aluminum alloy in accordance with AMS 4037. Total surface area is 150 square inches (968 cm^2).

4.4 Approval

4.4.1 Processes, control factors, or preproduction sample part or test panel, or any combination thereof specified, shall be approved by the cognizant engineering organization before production parts are supplied.

4.4.2 If the processor makes a significant change to any material, process, or control factor from that which was used for process approval, all preproduction tests shall be performed and the results submitted to the cognizant engineering organization for process reapproval, unless the change is approved by the cognizant engineering organization. A significant change is one which, in the judgment of the cognizant engineering organization, could affect the properties or performance of the parts.

4.4.3 Control factors for anodizing shall include, but not be limited to, the following:

Cleaning procedure, including the compositions and temperatures of the baths used
Deoxidation process
Anodizing bath composition including impurity limits, temperature, and agitation method
Rate of voltage rise, anodizing voltage, and time of anodizing
Sealing solution composition including impurity limits, temperature, and pH
Dye solution composition and temperature
Touch up, method if used
Purity of water used for sealing and rinsing
Periodic test plan for cleaning and processing solutions. See 8.4.

4.5 Reports